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(54) Title: LOW–FAT FOOD EMULSIONS HAVING CONTROLLED FLAVOUR RELEASE AND PROCESSES THEREFOR

(57) Abstract

Low–fat food emulsions comprise a continuous aqueous phase and a dispersed phase which comprises fat particles, gel particles and fat–soluble flavour molecules; substantially all of the fat particles are located within the gel particles, and at least 35w.% of the flavour molecules are located in a plurality of the gel particles. The rate of release of the flavour molecules from the emulsion is delayed and controlled following the gradual break down of the particles, thereby imparting the taste and mouthfeel of a full–fat emulsion.

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Low-fat food emulsions having controlled flavour release and processes therefor

Field of the Invention

The present invention relates to low-fat food emulsions, particularly to low-fat oil-in-water emulsions, and to processes for preparing these emulsions.

Background Art

Although an increasing number of consumers prefer low-fat food products over full fat food products, it is difficult for manufacturers of low-fat products to replicate the desired flavour and fatty mouthfeel of full-fat products. This difficulty is particularly a problem in low-fat oil-in-water emulsions such as dressings.

It has been demonstrated that lowering the fat content of foods gives rise to flavour imbalance, as the rate of flavour release is greater in fat-reduced foods; in this respect, reference is made to an article by Shamil et al in Food Quality and Preference 1991/2, 3 (1) 51-60 entitled "Flavour release and perception in reduced-fat foods".

The greater rate of flavour release in reduced-fat oil-in-water food emulsions is demonstrated by the present inventors in figure 1, which is a graph of profiles of flavour intensity against time for dressings having different levels of fat (see line 1 (traditional zero fat dressing) and line 2 (traditional 55 wt% fat dressing)).

During oral processing, full-fat (eg 55wt% fat) dressings exhibit a gradual build up of flavour to a low peak of maximum flavour impact, followed by a slow dissipation of

flavour. In contrast, traditional very low-fat/zero-fat (0.85% fat) dressings exhibit a rapid dissipation of flavour creating a very high peak of maximum flavour impact at an early stage of oral processing.

The profile exhibited by full-fat dressings equates to a taste and mouthfeel that are preferred by consumers: the profile exhibited by low-fat dressings equates to a flavour which is initially too intense, with no pleasing aftertaste.

Many important flavour molecules are lipophilic and hydrophobic. As fat levels are reduced in oil-in-water emulsions, a greater proportion of these flavour molecules are found in the water phase. When the emulsion is broken down, eg in the mouth during eating, the hydrophobic nature of the flavour molecules results in their rapid release into nasal airspace.

Developments in flavour technology have resulted in flavour molecules being encapsulated to control flavour release and to stabilise and protect the molecules. Commonly-used encapsulation techniques include spray-drying, bed fluidisation and coacervation. (See the reference "Encapsulation and Controlled Release" by Karsa and Stephensen, Royal Soc Chem, ISBN 0.85/86-6/5-8.)

These techniques involve entrapping a flavour molecule within a covering or microcapsule. The resulting encapsulated product is often in the form of small dry particles, which are added to foodstuffs. Upon heating or eating the foodstuffs, the particles are thermally or physically broken down to release the flavour molecules. The release is normally rapid.

US 5498439 discloses encapsulating flavour oils in a colloid gel, which is made from water and animal protein polymers or

plant polysaccharides. The flavour oil is mixed with the gel components under high shear pressure to create a stable colloid gel matrix, in which the flavour oil is physically encapsulated and retained by the hydrophilic nature of the gel. A solution of the encapsulated flavour oil may be injected into meat to impart flavour thereto.

Co-pending application PCT/EP98/00645 (WO98/34501) describes non-frozen, low fat food emulsions having a delayed flavour release. In this reference, delayed flavour release is achieved by preparing biopolymer gel particles which contain small oil droplets containing flavour molecules. A delayed flavour release was obtained. The delayed flavour release was found to be due to (hindered) diffusion due to the presence of the gel biopolymer material surrounding the oil droplets containing a large proportion of the flavour molecules. The particles remained (to a large extent) intact for 60 to 90 seconds after consumption.

Although the solutions as proposed in PCT/EP98/00645 are for many purposes satisfactory in terms of delayed flavour release, it still leaves the desire for a solution for achieving more control on the flavour release pattern for some applications.

The present invention seeks to provide a low-fat food emulsion having a rate of flavour release which is more comparable to that of a full-fat food emulsion (than to the release rate found in traditional low/zero fat products) and which flavour release rate can be delayed and controlled, thereby creating a low-fat food emulsion having the texture and flavour of a full-fat food emulsion or novel flavour profiles different from those of zero or full fat products.

Summary of the Invention

According to the present invention there is provided a low-fat food emulsion or dispersion comprising a continuous aqueous phase and a dispersed (or emulsified or suspended) phase which comprises fat particles, gel particles and fat-soluble flavour molecules, wherein at least 50% (but preferably substantially all) of the fat particles are located within the gel particles, and wherein at least 35% of the flavour molecules are located in a plurality of the gel particles to thereby delay the rate of release of the flavour molecules from the emulsion or suspension, and wherein at least part of the gel particles is gradually broken down in the mouth upon consumption, such that after 10 seconds after consumption the majority of the particles is still intact and 60 seconds after consumption at least the majority of the particles is no longer intact.

Detailed Description of the Invention

In the present invention, words like suspension, emulsion, or dispersion are used mixed, to describe the whole of the composition with in it the gelled particles. Although strictly speaking, as they are particles, they are suspended in the rest of the composition, and one should speak of a suspension. However, as they predominantly are made up of a gelled water phase (with in them oil droplets), this could also be regarded as an emulsion, which is why these words are also used herein to describe the system.

The actual amount of flavour molecules which is located in the gel particles will depend on the oil/water partition coefficient of the flavour molecules concerned. In the above, it is preferred that a plurality (i.e. more than 50 %) of the flavour molecules are located in a plurality of the gel

particles (which may be the case when the flavour molecule has a better solubility in oil than in water). The higher the percentage of the flavour molecules that is located in the gel particles, the better the delayed release is obtained.

For the purpose of the present invention, fat-soluble flavour molecules include flavour molecules which are totally soluble in fat or oil and flavour molecules which are only partially soluble in fat.

The gel particles are prepared from material comprising at least one food grade gel-forming biopolymer. The gel particles should be made such that they break down in the mouth upon consumption. This can be achieved by e.g. ensuring the particles are physically weak, so that they break down following shear forces that are present in the mouth. Weak particles can be obtained e.g. by using low concentrations of biopolymers when preparing them. Alternatively, the gel particles can be made from a material that breaks down following a trigger present in the mouth, e.g. gel particles from starch and/or derivatives thereof may be broken down by amylase present in the saliva, or particles made of gelatin may melt as a result of the temperature in the mouth. The biopolymer chosen for the gel particles may consist of a mixture and may also break down following a combination of break down triggers. An example of the latter are large, weak gelatin particles which break down following melting and as a result of shear forces. Starch, gelatin, agar (when used in low concentrations) and mixtures thereof are preferred biopolymers in this invention. Other biopolymers that could be used include carrageenan which can be made to melt close to mouth temperatures (via ion concentration and type), gellan, and pectin which could be made physically weak so that it breaks down under mouth shear, and CMC and Gum arabic which are used with gelatin to make coacervates which melt in

the mouth. Casein gels can also be made to breakdown in the mouth via shear. Most preferred are starch and/or starch derivatives, gelatin and agar.

Mixtures of proteins and polysaccharides are preferred as they may interact associatively, dissociatively, or synergistically.

The low-fat emulsion of the present invention may comprise between 0 and 30 wt% fat. Preferably the amount of fat is less than 10 wt% fat, more preferably less than 5 wt% fat. In a preferred embodiment, the emulsion comprises at least 0.01 wt% fat, more preferably at least 0.5 wt%. Emulsions having less than 3 wt% fat are also preferred: this very low level of fat are legitimately described as fat-free or zero-fat in many countries.

For the purpose of the present invention, the definition of fat includes liquid oil, crystallising fat blends and fat mimics such as sucrose polyesters.

When crystallising fat blends are used, enhanced control of flavour molecule transfer rates and additional textural benefits may be obtained.

The low-fat emulsion of the present invention may comprise from 0.1 to 99% by volume of gel particles, preferably from 5 to 50% by volume of gel particles. The gel particles may confer fat-like textural properties to the low-fat emulsion; in this respect, the emulsion preferably comprises from 20 to 99% by volume of gel particles.

The majority of the particles range in size from about 500 microns to about 8000 microns.

In the present invention it is believed that the profile of the flavour release is for the first few seconds (e.g. 10) is mainly diffusion controlled. If the material of the gel particles is well chosen, the rate of the flavour release is thereafter controlled by the speed of breakdown of the particles, in which their break down is described above. Usually, at 10 seconds after the microstructured emulsion (foodstuff) containing the emulsion is put in the mouth a minority is broken down. Over time, more and more particles break down causing a steady release of flavour molecules. After about 60 seconds, the majority of the particles is usually fully broken down. By chosing the material and size of the particles, the person skilled in the art can design the desired release profile, depending on the intended use.

The inventors of the claimed emulsion were surprised to find that the presence of gel particles delays the release of flavour molecules; this is surprising because the flavour molecules are of a size suitable for diffusing through the gel matrix of the particles. It is therefore understood that, in the present invention, the gel particles do not encapsulate the flavour molecules in the traditional sense, since the flavour molecules are not trapped within the gel particles.

Without wishing to be bound by theory, the inventors believe that the gel particles act as a static region within the mobile aqueous phase of the emulsion. When the emulsion is eaten, the aqueous phase is rapidly swept by oral fluids such as saliva, so that the flavour molecules are released very rapidly providing a very high initial flavour intensity which rapidly becomes depleted. A flavour molecule located in a gel particle diffuses therethrough as normal. By the time it has reached the surface of the gel particle to be swept by the oral fluids, a delay has occurred. Hence, flavour molecules

located in gel particles experience delayed release relative to flavour molecules in the aqueous phase. In the emulsion, the dispersed fat phase is normally in the form of liquid oil droplets located in the gel particles. As many important flavour molecules are lipophilic (fat-soluble) they have a preference for solubilising in the oil droplets. The rationale behind this approach is that in o/w emulsions the release of lipophillic flavours occurs in the sequence oil → water → air. It is therefore possible to control the release of lipophillic flavours by creating barriers around the oil droplets which hinder their release into the aqueous phase. Microstructured emulsions do this by increasing the diffusional pathway and reducing the rate at which lipophillic flavours are released into the aqueous phase.

However, it has become apparent that particles that break down slowly during mastication (`mouth degradable particles') enable flavour release profiles to be obtained which exhibit very different flavour release profiles from thatof both traditional low- and high-fat products. By controlling the properties of the gel particles, the oral breakdown of the el particles can be controlled, and following this, the flavour release can be controlled.

In accordance with the present invention there is also provided a process for the preparation of a low-fat food emulsion comprising the steps of

a) admixing fat and a gel-forming biopolymer to form a first liquid phase

b) adding the first liquid phase to a second liquid phase which promotes gel formation of the biopolymer to form gel particles having particles of fat located therein

c) mixing the gel particles with an aqueous phase and fat-soluble flavour molecules to form an aqueous-continuous emulsion, wherein at least part of the gel particles is gradually broken down in the mouth upon consumption, such that 10 seconds after consumption the majority of the particles is still intact and 60 seconds after consumption at least the majority of the particles is no longer intact.

Optionally, the first liquid phase is emulsified prior to step b. In step b, the first liquid phase may be injected into the second liquid phase. Alternatively, in step b, the first liquid phase may be sprayed on to the second liquid phase.

The second liquid phase may have a lower temperature than the first liquid phase in order to effect gel formation. Alternatively, the second liquid phase may react with the biopolymer in the first liquid phase in order to effect gel formation.

An emulsion according to the present invention may also be prepared using one of the following processes.

1) Shear Gel Method
Heat and homogenise the emulsion ingredients to form an oil in water emulsion. Cool the emulsion under shear.

2) Multiple Emulsion Method
Heat and homogenise the emulsion ingredients to form an oil in water in oil (duplex) emulsion. Cool the emulsion under shear and remove the outer oil phase.

When preparing a low-fat emulsion in accordance with the present invention, flavour components need minimal rebalancing to account for the low phase volume of fat.

Also, critical flavours, which are normally fat-soluble and therefore particularly prone to uncontrolled release in low fat emulsions, are released according to their "full-fat" timescale, thereby improving the perception of their flavour.

The present invention provides means for controlling the transfer rates, including the rate of release, of flavour molecules in an emulsion, thereby allowing manipulation of the flavour release profile of low-fat emulsions. It also provides means for manipulating the texture of low-fat emulsions. Hence, low-fat emulsions can be prepared which have the taste and mouthfeel of full-fat emulsions. The present invention achieves this without recourse to an encapsulating coating which must be heated or solubilised in order to release encapsulated flavours.

The present invention can be applied in the manufacture of products like spreads, dressings, mayonnaise, sauces, ice-cream (including water-ice) etcetera, and related products that are regarded as the products mentioned above, being low in fat (including those products that are regarded as zero fat, but still contain few percentages of fat).

Brief description of drawings

Figure 1: Flavour intensity over time for zero fat and 55% fat dressings.
Figure 2: Flavour intensity over time for zero fat (both control and according to invention) and 55% fat dressings.
Figure 3: Flavour intensity over time for zero fat (both control and according to invention) and 55% fat dressings.
Figure 4: Flavour intensity over time for various dressings.
Figure 5: Flavour intensity over time for various dressings.
Figure 6: Flavour intensity over time for various spreads.
Figure 7: Flavour intensity over time for various ice-creams.
Figure 8: Flavour intensity over time for various dressings.

The invention is further exemplified by the following examples, which are to be understood as to be non-limiting.

Example 1

Starch gel particles (amylase trigger)

A native starch (comprising 80% amylopectin and 20% amylose) emulsion containing 10 wt% sunflower oil emulsified with 0.5% whey protein concentrate was poured into small eliptical moulds and placed into a refridgerator at 5°C overnight until the starch gelled. These beadlets were added to a model dressing to give an oil level of 1 wt%. The flavour molecules ethyl hexanoate was added to the dressing and left for 48 hours to equilibrate in a sealed bottle.

A traditional full-fat dressing was prepared using xanthan gum and sunflower oil, to give an oil level of 55 wt%. The flavour molecule ethyl hexanoate was added to the dressing and left for 48 hours to equilibrate in a sealed bottle. A flavour intensity over time profile was plotted and compared to a control 1wt% emulsion in which the oil was dispersed in the continuous phase. The resulting profiles are shown in figure 2.

Results

It can be seen that the from the low-fat dressing in which the oil is located outside the gel particles, the flavour molecules of ethyl hexanoate are rapidly released, resulting in a very high peak of flavour intensity, followed by a rapid dissipation of the flavour intensity.

However , it can be seen that the low-fat dressing containing the present invention with the starch particles

containing the oil, the flavour release profile for ethyl hexanoate exhibits a very gradual build up of flavour to a low intensity which is maintained throughout the eating time. The starch particles are very soft and highly deformable which probably begin to fragment and break down during the eating process. It is very clear that the temporal flavour release profile is identical to the flavour release profile from the traditional full-fat dressing which exhibits a very gradual build up of flavour to a low intensity which is maintained as a plateau throughout the eating process.

Example 2

The methods of example 1 were repeated but using heptan-2-one rather than ethyl hexanoate as the flavour molecule marker.

A traditional full-fat dressing was prepared using xanthan gum and sunflower oil, to give an oil level of 55 wt%. The flavour molecule ethyl hexanoate was added to the dressing and left for 48 hours to equilibrate in a sealed bottle.

A flavour intensity over time profile was plotted and compared to a control 1wt% emulsion in which the oil was dispersed in the continuous phase. The resulting profiles are shown in figure 3.

Results

It can be seen that the from the low-fat dressing in which the oil is located outside the gel particles, the flavour molecules of heptan-2-one are rapidly released, resulting in a very high peak of flavour intensity, followed by a rapid dissipation of the flavour molecules.

However, it can be seen that the low-fat dressing with the starch particles containing the oil, the flavour release profile for heptan-2-one exhibits a more gradual build up of flavour to a lower intensity in the early stages of oral processing which is maintained throughout the eating time. Although at a higher intensity it is clear that the temporal flavour release profile containing the current invention is very similar to the traditional full fat dressing which exhibits a very gradual build up of flavour to a low intensity which is maintained as a plateau throughout the eating process.

Example 3

gelatin gel particles (temperature trigger)

Gelatin emulsions containing 10 wt% sunflower oil were made with different hardness and melting times by altering the gelatin concentration between 2.0% and 5.0%. The emulsions were poured into small eliptical moulds and placed in the refrigerator at 5°C overnight or until the gelatin gelled. These particles were added to a model dressing to give an oil level of 1 wt%. The flavour molecules ethyl hexanoate was added to the dressing and left for 48 hours to equilibrate in a sealed bottle.

A traditional full-fat dressing was prepared using xanthan gum and sunflower oil, to give an oil level of 55 wt%. The flavour molecule ethyl hexanoate was added to the dressing and left for 48 hours to equilibrate in a sealed bottle.

A flavour intensity over time profile was plotted and compared to a control 1wt% emulsion in which the oil was dispersed in the continuous phase. The resulting profiles are shown in figure 4.

Results

It can be seen that the from the low-fat dressing in which the oil is located outside the gel particles, the flavour molecules of ethyl hexanoate are rapidly released, resulting in a very high peak of flavour intensity, followed by a rapid dissipation of the flavour intensity.

It can be seen that the flavour profile for the low-fat dressing containing the present invention with the gelatin particles containing the oil, demonstrates that not only the flavour intensity has been adjusted but the shape of the release profile has also been modified which is dependent on the time taken to melt the gelatin. In the case of the 5% gelatin particles the initial flavour intensity is reduced providing a gradual build up of flavour to a low intensity which is sustained for about 50 seconds. At this point the flavour intensity begins to rise rapidly which is due to the gelatin particles melting. In the case of the dressing containing the 2% gelatin particles, the flavour release profile shows a gradual increase in flavour intensity throughout the eating process and is clearly different to the flavour profile from the dressing containing 5% gelatin particles. Both the temporal flavour release profiles from the two dressings containing the present invention are different fron the flavour release profile from the traditional full-fat dressing which exhibits a very gradual build-up of flavour to a low intensity which is maintained as a plateau throughout the eating process.

Example 4

Coacervate gel particles (temperature trigger) in dressings

Powdered gelatin (3%w/w) was dispersed into cold distilled water and heated to 70°C until all the gelatin was

dissolved. This solution was cooled to 40°C. Gum arabic (3%w/w) was also dispersed in cold distilled water and heated to 80°C until all the gum arabic was dissolved. Sunflower oil (3% w/w) was added and sheared (Silverson lab mixer) until a stable emulsion was produced. The emulsion was cooled to 40°C. The gelatin solution was added very slowly to the gum arabic emulsion with continued gentle stirring at 40°C. Finally, GDL (0.5%) dissolved in a small volume of water was added to the gelatin-gum arabic solution which was kept for two hours under gentle stirring above 35°C. The pH was monitored so that it reached a value ranging between 3.6-3.3. This final solution was immediately cooled in an ice bath while still under gentle stirring to produce the coacervates which had a particle size of approximately 100-500 microns. The coacervate particles were allowed to settle and the supernatant was decantered off.

The coacervates were added to a model dressing to give an oil level of 3 wt%. The flavour ethyl hexanoate was added to the dressing and left for 48 hours to equilibrate in a sealed bottle.

A traditional full-fat dressing was prepared using xanthan and sunflower oil, to give an oil level of 55wt%. The flavour molecule ethyl hexanoate was added to the dressing and left for 48 hours to equilibrate in a sealed bottle.

A flavour intensity over time profile was plotted and compared to a control 3 wt% emulsion in which the oil was dispersed in the continuous phase. The resulting profiles are shown in figure 5.

Results
It can be seen that the from the low-fat dressing in which the oil is located outside the gel particles, the flavour molecules of ethyl hexanoate are rapidly released, resulting in a very high peak of flavour intensity, followed by a rapid dissipation of the flavour intensity.

However, it can be seen that the low-fat dressing containing the present invention (with the coacervate particles containing the oil), which melt down very slowly provide a flavour release profile for ethyl hexanoate which exhibits a very gradual build up of flavour to a low intensity which is maintained throughout the eating time.

It is very clear that the temporal flavour release profile is identical to the flavour release profile from the traditional full-fat dressing which exhibits a very gradual build up of flavour to a low intensity which is maintained as a plateau throughout the eating process.

Example 5
Coacervate gel particles in spreads
The method of example 4 for the preparation of the coacervates was repeated but the coascervates were added to a model spread to give an oil level of 3 wt%. The flavour ethyl hexanoate was added to the spread and left for 48 hours to equilibrate in a sealed bottle.

A traditional full-fat spread was prepared using maltodextrin (SA2) and sunflower oil, to give an oil level of 40wt%. The flavour molecule ethyl hexanoate was added to the spread and left for 48 hours to equilibrate in a sealed bottle.

A flavour intensity over time profile was plotted and compared to a control 3 wt% emulsion in which the oil was dispersed in the continuous phase. The resulting profiles are shown in figure 6.

Results

It can be seen that the from the low-fat spread in which the oil is located outside the gel particles, the flavour molecules of ethyl hexanoate are rapidly released, resulting in a very high peak of flavour intensity, followed by a rapid dissipation of the flavour intensity.

However, it can be seen that the low-fat spread containing the present invention (with the coacervate particles containing the oil), which melt down very slowly provide a flavour release profile for ethyl hexanoate which exhibits a very gradual build up of flavour to a low intensity which increases in intensity very slowly due to the melting of the particle during the eating process.

It is very clear that the temporal flavour release profile is closer to the flavour release profile from the traditional full-fat dressing which exhibits a very gradual build up of flavour to a low intensity which is maintained as a plateau throughout the eating process.

Example 6

Coacervate gel particles in ice-cream

The method of example 4 for the preparation of the coacervates was repeated but the coacervates were added to a model ice-cream to give an oil level of 3 wt%. The flavour ethyl hexanoate was added to the ice-cream and left for 48 hours to equilibrate in a sealed bottle.

A traditional full-fat ice-cream was prepared using skim milk powder, sucrose, xanthan and sunflower oil, to give an oil level of 12.8wt%. The flavour molecule ethyl hexanoate was added to the ice-cream and left for 48 hours to equilibrate in a sealed bottle.

A flavour intensity over time profile was plotted and compared to a control 3 wt% emulsion in which the oil was dispersed in the continuous phase. The resulting profiles are shown in figure 7.

Results

It can be seen that the from the low-fat ice-cream in which the oil is located outside the gel particles, the flavour molecules of ethyl hexanoate are rapidly released, resulting in a very high peak of flavour intensity, followed by a rapid dissipation of the flavour intensity. However, it can be seen that the low-fat ice-cream containing the present invention (with the coacervate particles containing the oil), which melt down very slowly provide a flavour release profile for ethyl hexanoate which exhibits a very gradual build up of flavour to a low intensity which increases in intensity very slowly due to the melting of the particle during the eating process.

It is very clear that the temporal flavour release profile is closer to the flavour release profile from the traditional full-fat ice-cream which exhibits a very gradual build up of flavour to a low intensity which is maintained as a plateau throughout the eating process.

Example 7

Dressing containing agar particles

Agar emulsions containing 10 wt% sunflower oil emulsified with o.5% whey protein concentrate were prepared of different

hardness by altering the agar concentration between 0.5% and 1.0%. The emulsions were poured into small elliptical moulds and placed in a refridgerator at 5°C overnight until the agar gelled. These beadlets were added to a model dressing to give an oil level of 1 wt%. The flavour molecule ethyl hexanoate was added to the dressing and left for 48 hours to equilibrate in a sealed bottle.

A traditional full-fat dressing was prepared using xanthan gum and sunflower oil, to give an oil level of 55 wt%. Ehtyl hexanoate was added to the dressing and left for 48 hours to equilibrate in a sealed bottle.

Flavour intensity over time profiles were plotted and compared to a control 1 wt% emulsion in which the oil was dispersed in the continuous phase. The resulting profiles are shown in figure 8.

Results

The profiles show that the initial flavour intensity is suppressed and is not dependant on the hardness of the particles. However, att longer intervals the flavour release curve appears to be dependent upon both the hardness of the particle (increasing intensity with decreasing hardness) and on the fragmentation of the particle during the oral process. The low fat dressing which contains the present invention with 1% agar has different flavour release profile whcih exhibits a very gradula build up of flavour to a low intensity which is maintained until the agar particle starts to fragment which the causes more ethyl hexanoate to be released. The low fat dressing which contains the present invention with 0.5% agar has a flavour release profile which is very similar in shape to that of a full fat dressing. There is a gradual build up of flavour intensity (which is

slightly higher than that for the 1% agar product in the initial stages) and which is maintained throughout the eating process. These emulsion particles are the most soft and start to fragment much earlier in the mouth than the 1% agar particle.

Claims

1. A low-fat food emulsion comprising a continuous aqueous phase and a dispersed phase which comprises fat particles, gel particles and fat-soluble flavour molecules, wherein at least 50% of the fat particles are located within the gel particles, and wherein at least 35% of the flavour molecules are located in a plurality of the gel particles to thereby delay the rate of release of the flavour molecules from the emulsion, and wherein at least part of the gel particles is gradually broken down in the mouth upon consumption, such that after 10 seconds after consumption the majority of the particles is still intact and 60 seconds after consumption at least the majority of the particles is no longer intact.

2. An emulsion according to claim 1, wherein substantially all of the fat particles are located within the gel particles, and wherein at least 35% of the flavour molecules are located in a plurality of the gel particles to thereby delay the rate of release of the flavour molecules from the emulsion, and wherein at least part of the gel particles is gradually broken down in the mouth upon consumption, such that after 10 seconds after consumption the majority of the particles is still intact and 60 seconds after consumption at least the majority of the particles is no longer intact.

3. An emulsion according to claim 1 or 2, wherein the dispersed phase which comprises fat particles, gel particles and fat-soluble flavour molecules, wherein substantially all of the fat particles are located within the gel particles, and wherein a plurality of the flavour molecules are located in a plurality of the gel particles to thereby delay the rate of release of the flavour molecules from the emulsion.

4. An emulsion as claimed in claims 1-3 wherein the gel particles are prepared from the biopolymers starch, derivatives of starch, gelatin, agar, locust bean gum, konjac mannan, carrageenan, gellan, pectin, CMC, gum arabic, casein, or mixtures thereof.

5. An emulsion as claimed in claims 1-4, wherein the gel particles are prepared of biopolymers of which at least 50% by weight is selected from the group consisting of starch, derivatives of starch, gelatin, agar and mixtures thereof.

6. An emulsion as claimed in any preceding claim comprising from 0 to 30 wt% fat.

7. An emulsion as claimed in claim 6 comprising less than 10 wt% fat.

8. An emulsion as claimed in claim 7 comprising less than 5 wt% fat.

9. An emulsion as claimed in any preceding claim comprising from 0.1 to 99.0 % by volume of gel particles.

10. An emulsion as claimed in claim 9 comprising from 5.0 to 50.0% by volume of gel particles.

11. An emulsion as claimed in claim 10 comprising from 20.0 to 99.0% by volume of gel particles.

12. An emulsion as claimed in any preceding claim wherein at least 90% of the gel particles have a size of at least 30 microns and less than 5000 microns.

13. An emulsion as claimed in claim 12 wherein at least 90% of the gel particles have a size of at least 50 and less than 1000 microns.

14. An emulsion as claimed in claim 13 wherein at least 90% of the gel particles have a size of at least 100 to less than 500 microns.

15. A process for the preparation of a low-fat food emulsion comprising the steps of
a) admixing fat and a gel-forming biopolymer to form a first liquid phase
b) adding the first liquid phase to a second liquid phase which promotes gel formation of the biopolymer to form gel particles having particles of fat located therein
c) mixing the gel particles with an aqueous phase and fat-soluble flavour molecules to form an aqueous-continuous emulsion, wherein at least part of the gel particles is broken down in the mouth upon consumption, such that after 10 seconds after consumption the majority of the particles is still intact and 60 seconds after consumption at least the majority of the particles is no longer intact.

16. A process as claimed in claim 15, wherein, in step b, the second liquid phase has a lower temperature than the first liquid phase in order to promote gel formation.

17. A process as claimed in claim 15, wherein, in step b, the second liquid phase reacts with the biopolymer of the first liquid phase in order to promote gel formation.

18. Food product containing an emulsion according to claim 1-14, wherein the food product is a dressing, mayonnaise, spread or ice-cream.

Fig.1.

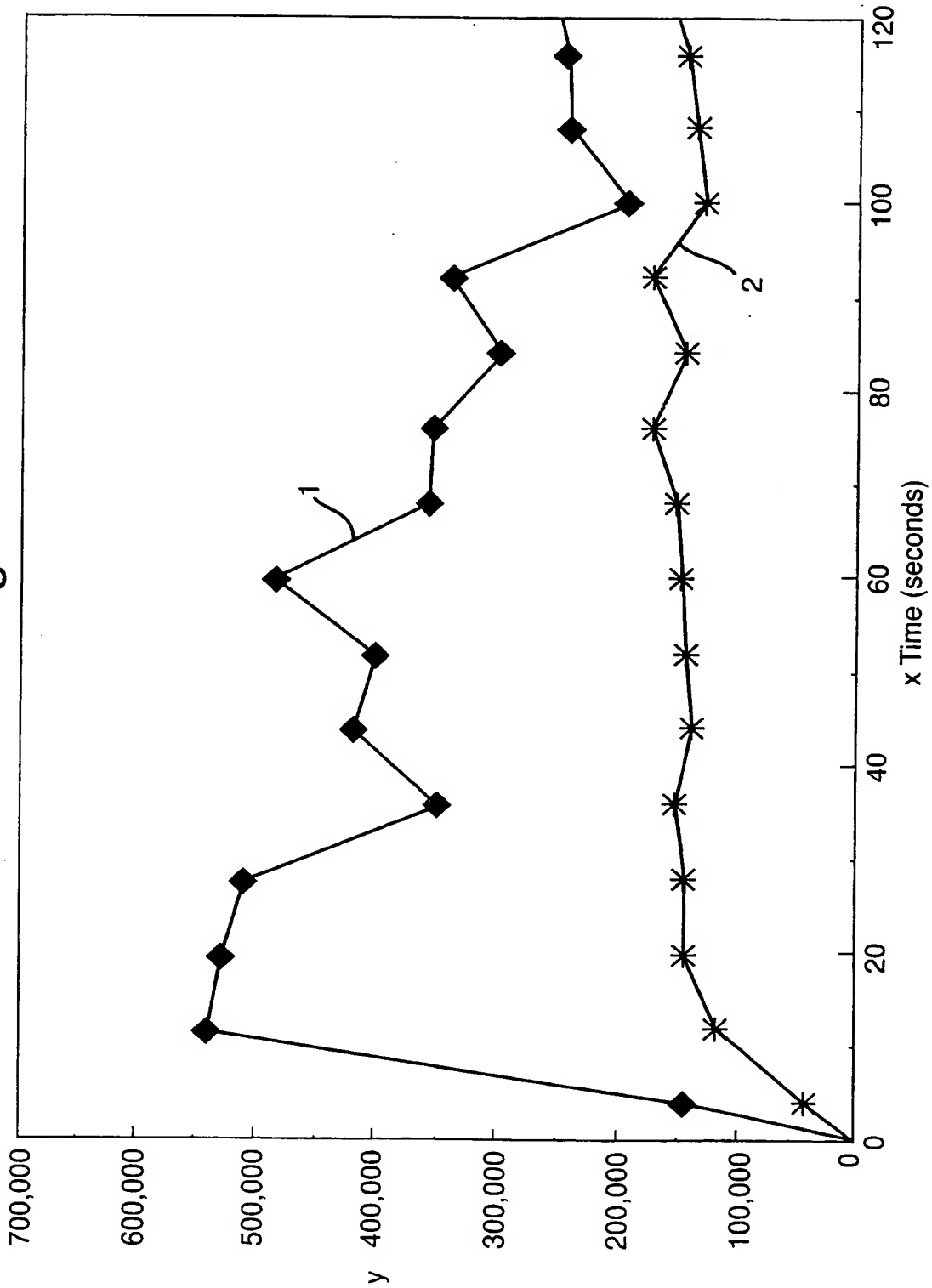

700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
y
0
20
40
60
80
100
120
x Time (seconds)
1
2

Fig.2.

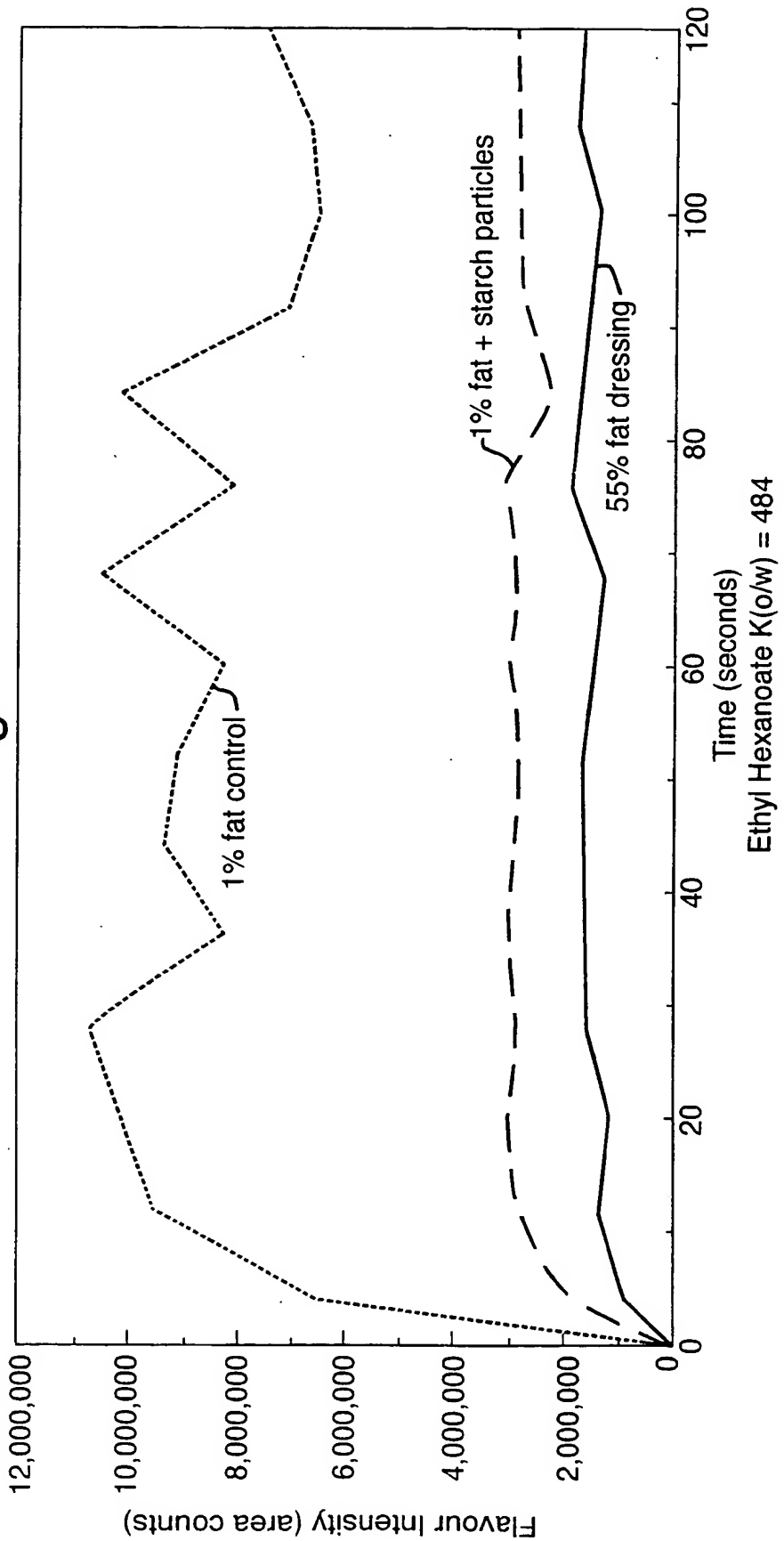

Flavour Intensity (area counts)
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
0
20
40
60
80
100
120
Time (seconds)
Ethyl Hexanoate K(o/w) = 484
1% fat control
1% fat + starch particles
55% fat dressing

Fig.3.

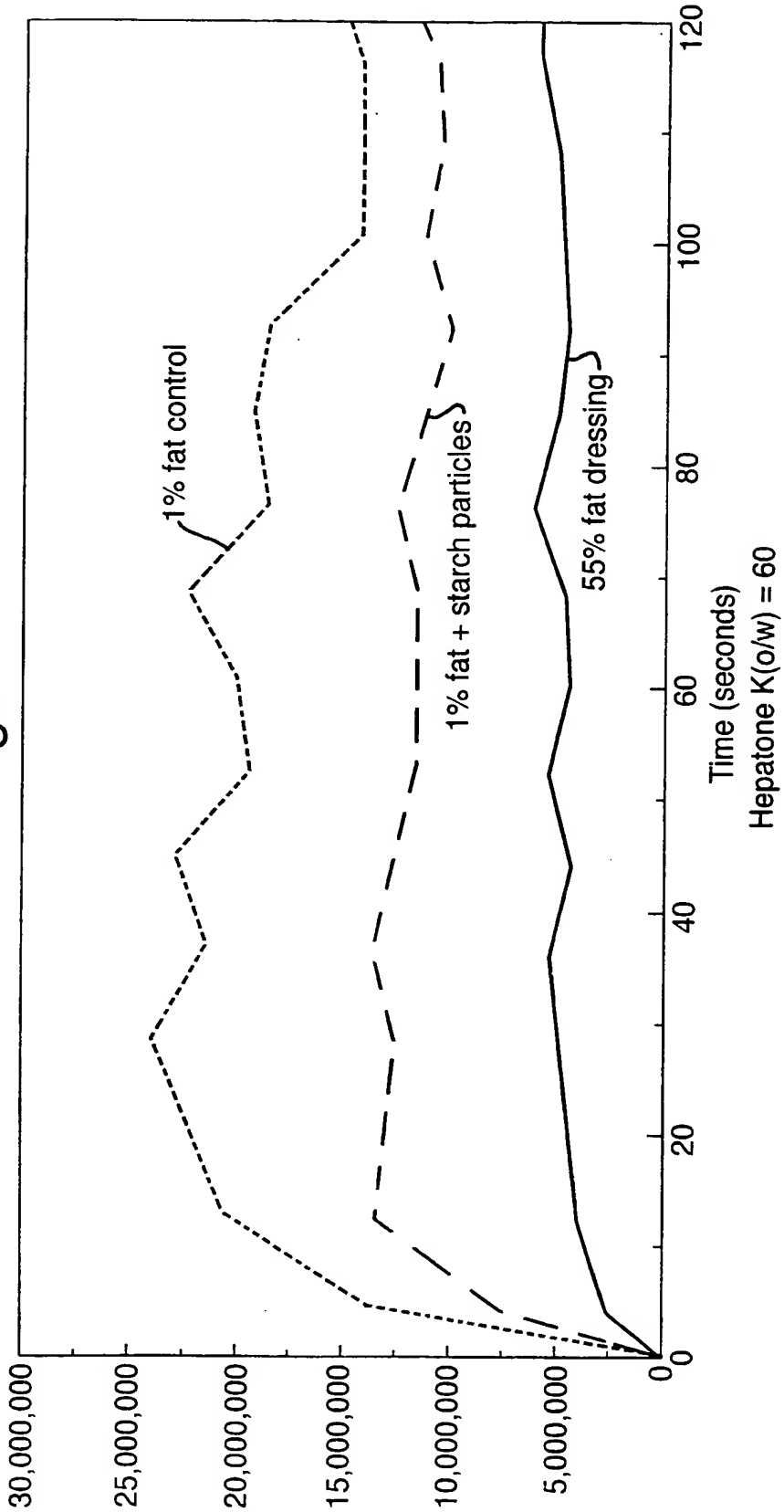

1% fat control
1% fat + starch particles
55% fat dressing
Flavour Intensity (area counts)
30,000,000
25,000,000
20,000,000
15,000,000
10,000,000
5,000,000
0
0
20
40
60
80
100
120
Time (seconds)
Hepatone K(o/w) = 60

Fig.4.

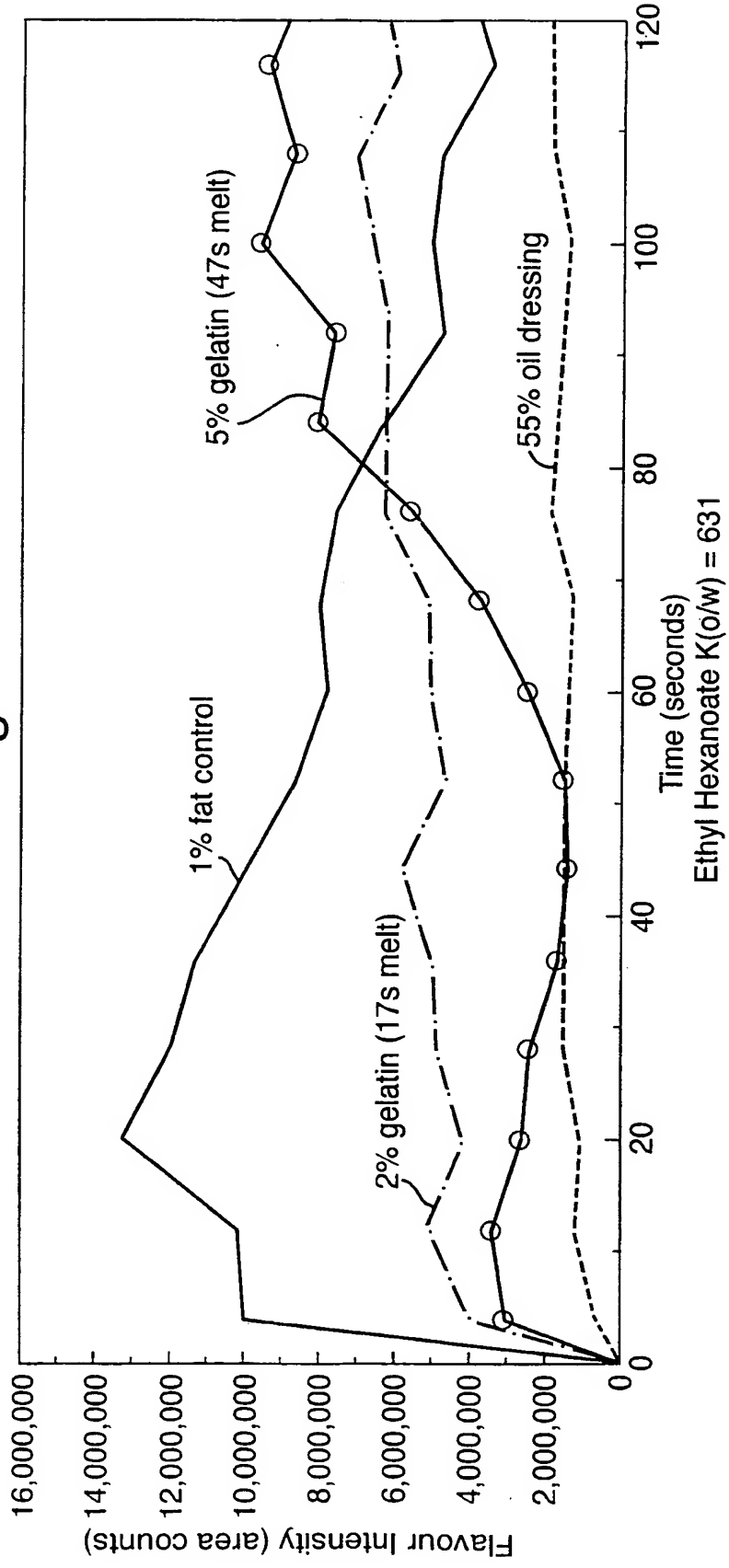

Flavour Intensity (area counts)
16,000,000
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
20
40
60
80
100
120
Time (seconds)
Ethyl Hexanoate K(o/w) = 631
1% fat control
5% gelatin (47s melt)
2% gelatin (17s melt)
55% oil dressing

Fig.5.

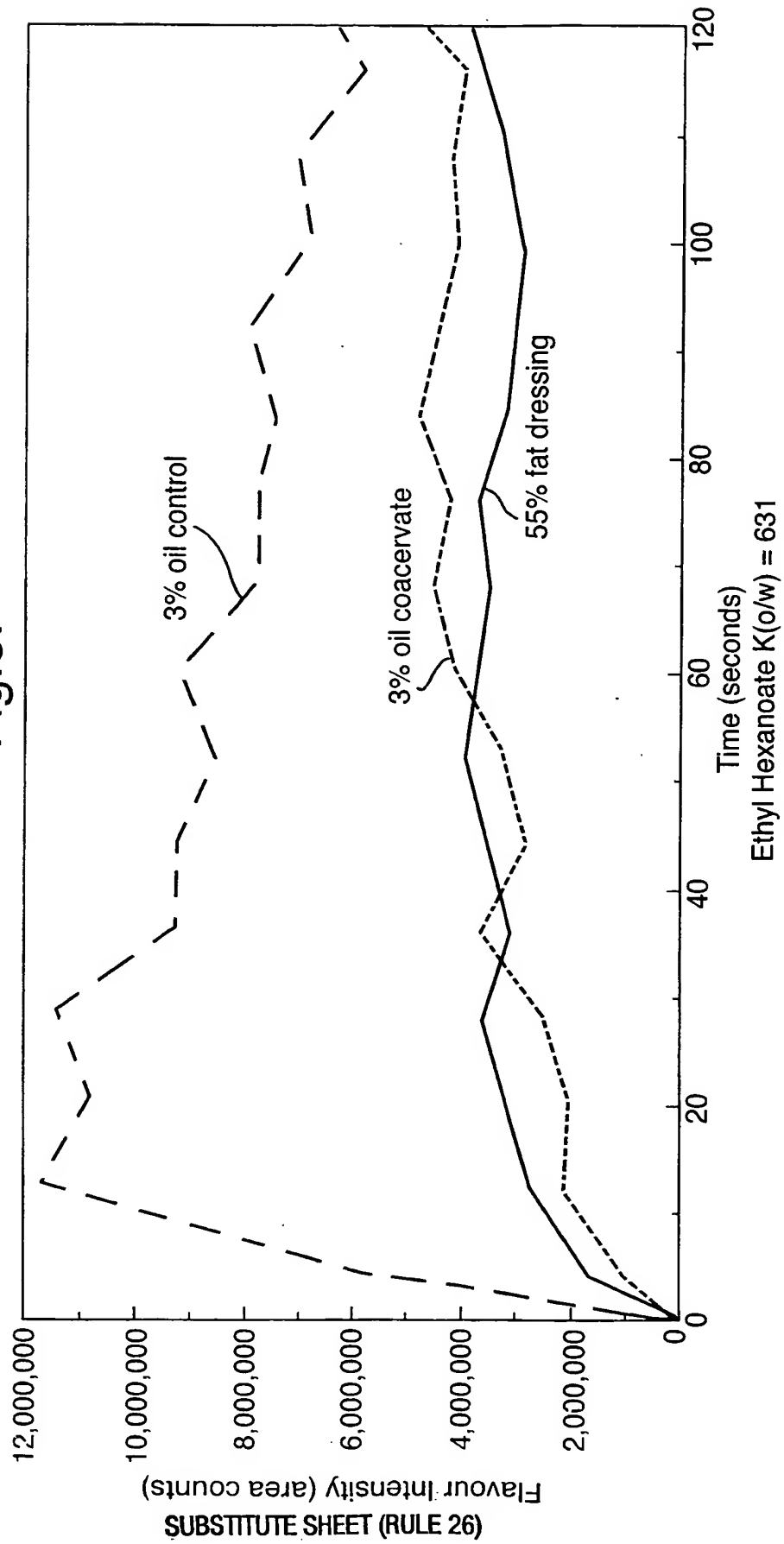

3% oil control
3% oil coacervate
55% fat dressing
Flavour Intensity (area counts)
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
20
40
60
80
100
120
Time (seconds)
Ethyl Hexanoate K(o/w) = 631

Fig.6.

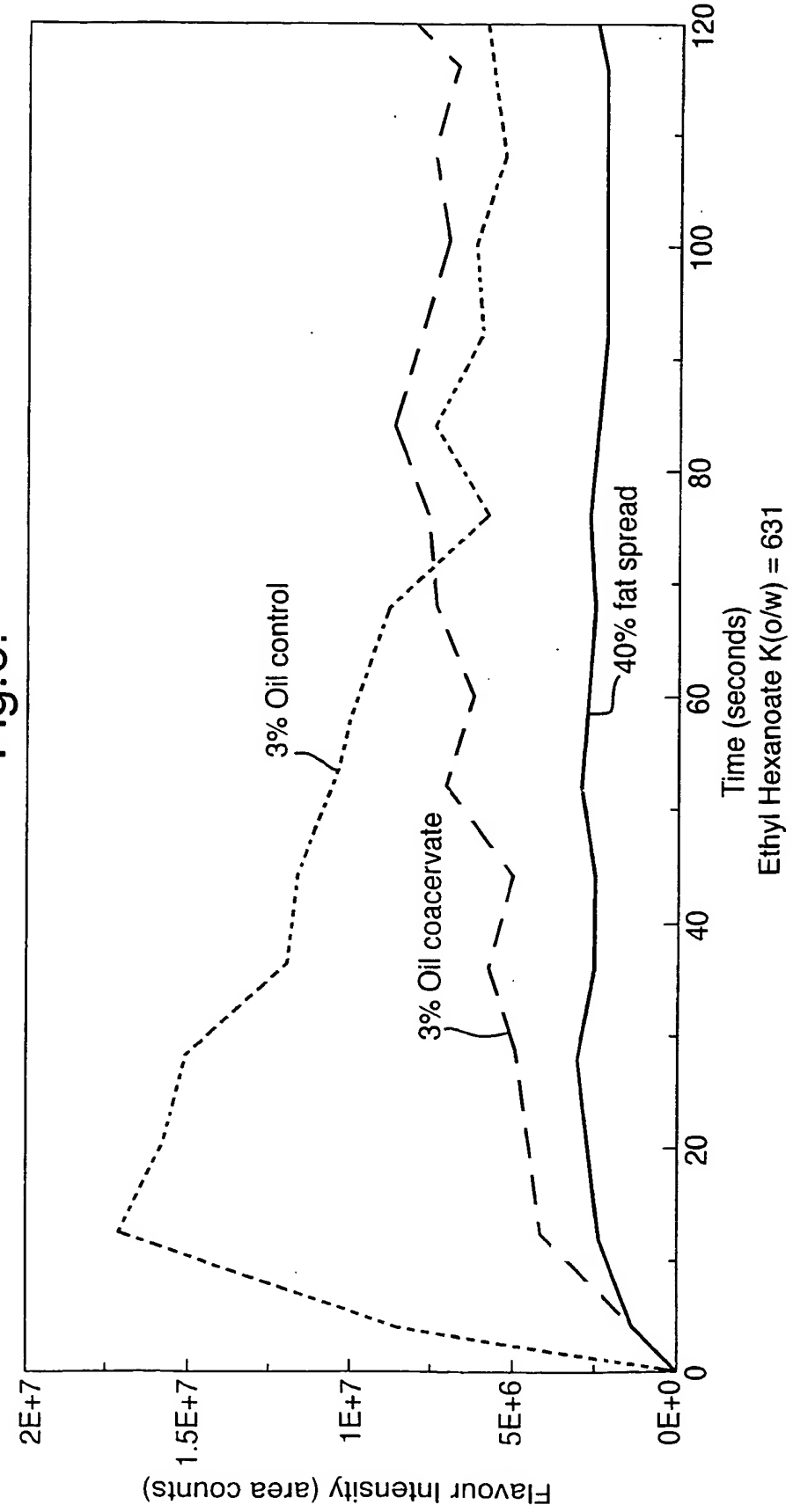

Flavour Intensity (area counts)
2E+7
1.5E+7
1E+7
5E+6
0E+0
0
20
40
60
80
100
120
Time (seconds)
Ethyl Hexanoate K(o/w) = 631
3% Oil control
3% Oil coacervate
40% fat spread

Fig.7.

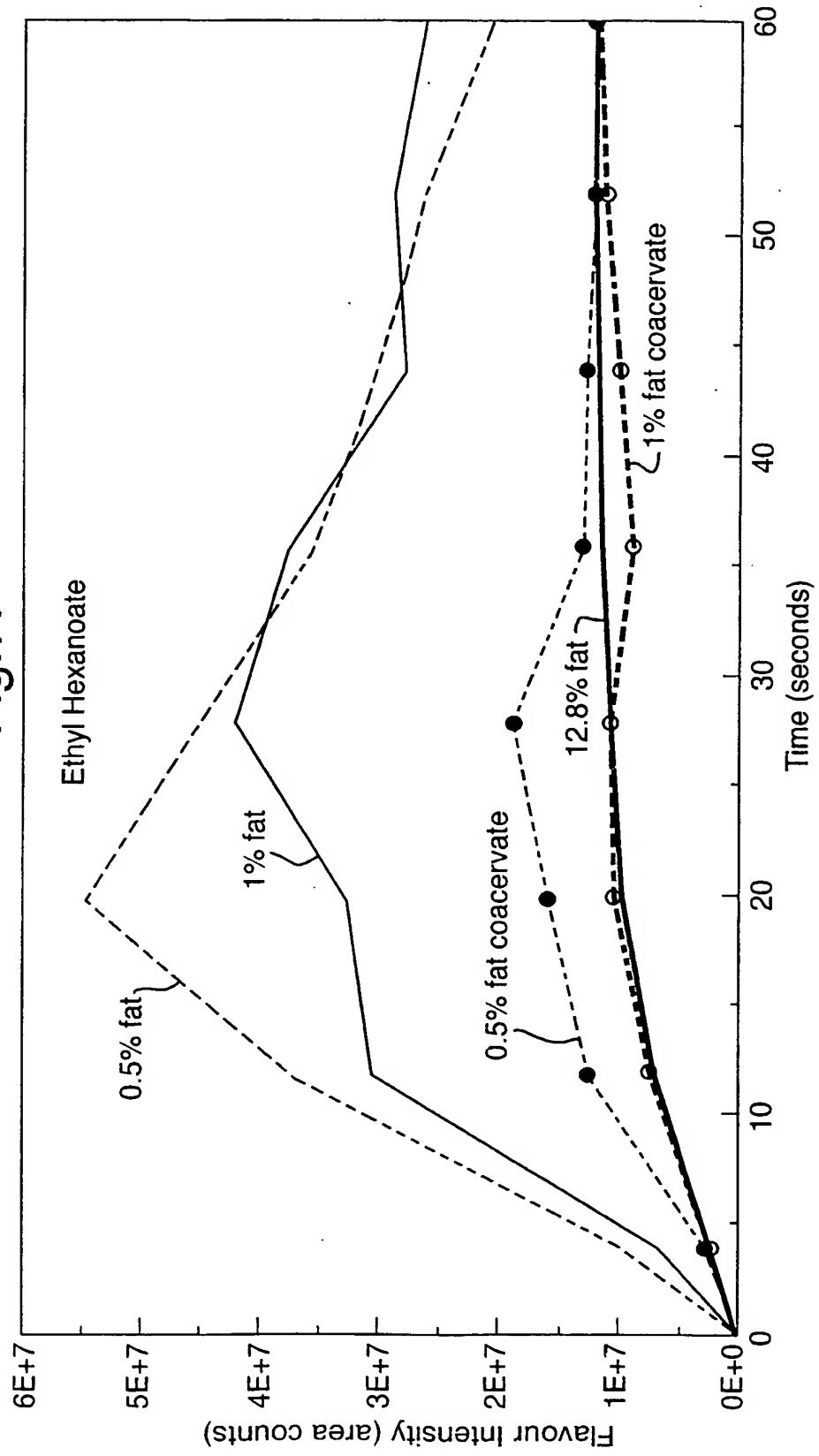
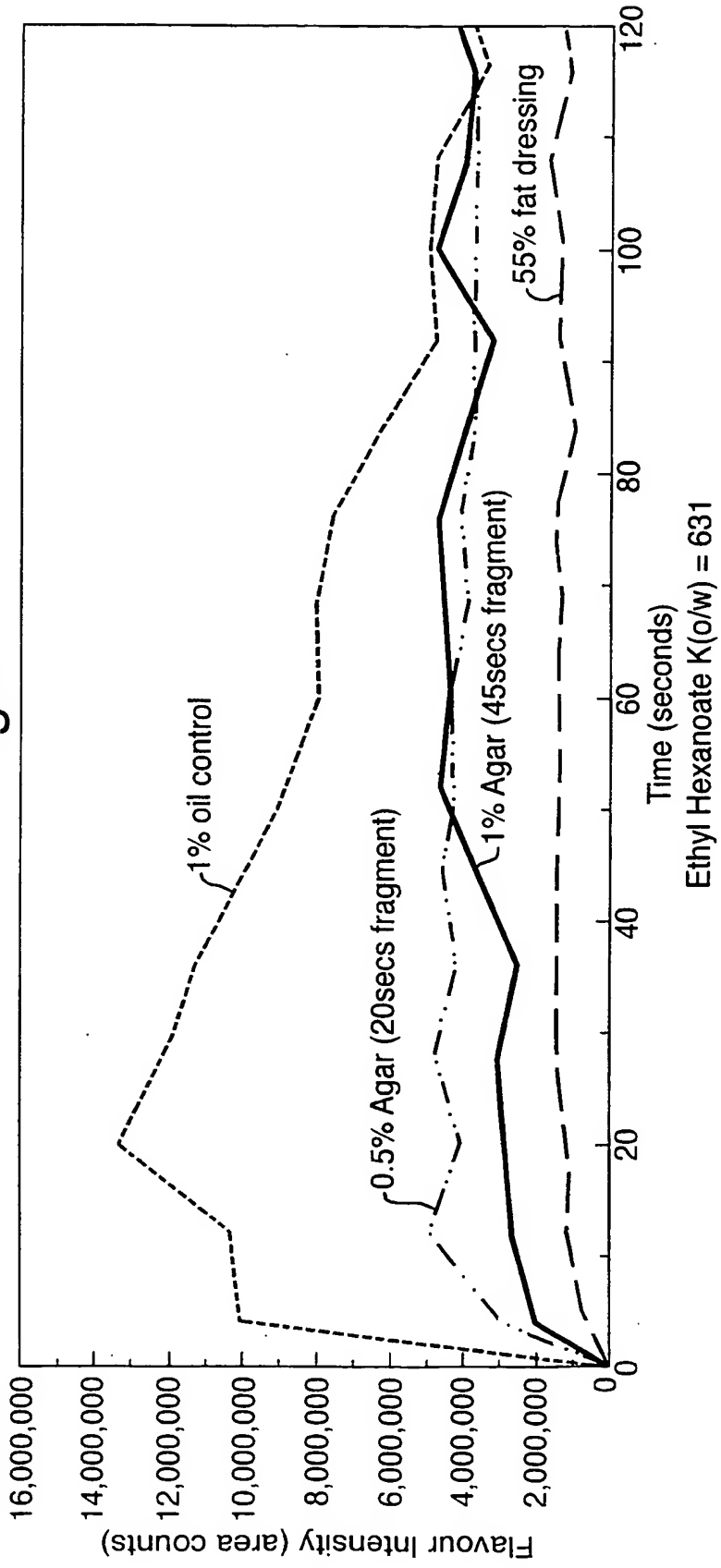

Ethyl Hexanoate
0.5% fat
1% fat
0.5% fat coacervate
12.8% fat
1% fat coacervate
Flavour Intensity (area counts)
Time (seconds)
0E+0
1E+7
2E+7
3E+7
4E+7
5E+7
6E+7
0
10
20
30
40
50
60

Fig.8.


Flavour Intensity (area counts)
16,000,000
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
0
20
40
60
80
100
120
Time (seconds)
Ethyl Hexanoate K(o/w) = 631
1% oil control
0.5% Agar (20secs fragment)
1% Agar (45secs fragment)
55% fat dressing

INTERNATIONAL SEARCH REPORT

Interr nal Application No
PCT/EP 99/05041

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A23L1/22 A23L1/24 A23D7/00 A23G9/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A23L A23D A23G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,A	WO 98 34501 A (UNILEVER PLC ;UNILEVER NV (NL)) 13 August 1998 (1998-08-13) cited in the application example 5 figure 5 claims 1-17	1-18
A	WO 90 00354 A (NUTRASWEET CO) 25 January 1990 (1990-01-25) example 4 claims 1-26	1,15,18
A	EP 0 558 113 A (UNILEVER NV ;UNILEVER PLC (GB)) 1 September 1993 (1993-09-01) examples 4-6 claims 1-12	1,15,18

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 November 1999	25/11/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Dekeirel, M

INTERNATIONAL SEARCH REPORT

ormation on patent family members

Interr nal Application No
PCT/EP 99/05041

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